
PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Northern Pikeminnow Management Program

BPA project number: 9007700

Contract renewal date (mm/yyyy): 4/1999

☐ Multiple actions?

Business name of agency, institution or organization requesting funding

Pacific States Marine Fisheries Commission

Business acronym (if appropriate)

PSMFC

Proposal contact person or principal investigator:

Name	Russell Porter
Mailing Address	45 S.E. 82nd Drive, Suite 100
City, ST Zip	Gladstone, OR 97027
Phone	(503) 650-5400
Fax	(503) 650-5426
Email address	russell_porter@psmfc.org

NPPC Program Measure Number(s) which this project addresses

5.7A.1, 5.7B.1, 5.7B.2, 5.7B.3, 5.7B.4, 5.7B.5, 5.7B.6

FWS/NMFS Biological Opinion Number(s) which this project addresses

ND-NMFS BO RPA No. 14;

Columbia River Northern Squawfish Management Program BO - 4/25/95

Other planning document references

Proposed Recovery Plan For Snake River Salmon (NMFS), Task 2.8.a.1;

Wy-Kan-Ush-Me Wa-Kush-Wit, Technical Recommendations;

Return to the River, 7F

Short description

Reduce predation on juvenile salmonids by implementing fisheries to harvest northern pikeminnow in the mainstem Columbia and Snake rivers. Monitor effects of fisheries on predation by northern pikeminnow and other resident fish.

Target species

Northern pikeminnow; all species and races of anadromous salmonids present

Section 2. Sorting and evaluation

Subbasin

Mainstem

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
<input checked="" type="checkbox"/> Anadromous fish <input type="checkbox"/> Resident fish <input type="checkbox"/> Wildlife	<input checked="" type="checkbox"/> Multi-year (milestone-based evaluation) <input type="checkbox"/> Watershed project evaluation	<input type="checkbox"/> Watershed councils/model watersheds <input type="checkbox"/> Information dissemination <input type="checkbox"/> Operation & maintenance <input type="checkbox"/> New construction <input type="checkbox"/> Research & monitoring <input checked="" type="checkbox"/> Implementation & management <input type="checkbox"/> Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
20515	Mainstem Columbia River Umbrella Proposal
9306000	Evaluate Columbia River Select Area Fisheries
8906900	Annual Coded Wire Tag Program - Missing Production Oregon Hatcheries
8201300	Coded Wire Tag Recovery Program
9105	Determine if Salmon Are Successfully Spawning Below Lower Columbia Dams
9600800	PATH-Participation by State & Tribal Agencies
8810804	Streamnet: The Northwest Aquatic Information Network
8605000	White Sturgeon Mitigation & Restoration in the Columbia & Snake Rivers
9079	Inventory Resident Fish in Bonneville, The Dalles, & John Day Reservoirs
9705900	Securing Wildlife Mitigation Sites in Oregon
9705904	Securing Wildlife Mitigation Sites in Oregon - Horn Butte
9705911	Securing Wildlife Mitigation Sites in Oregon - Irrigon WMA Addition
9705909	Securing Wildlife Mitigation Sites in Oregon - Mitchell Point

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9007800	Evaluate Predator Control and Provide Technical Support for PATH	9007800 would have little to evaluate if 9007700 was not conducted
9702400	Avian Predation on Juvenile Salmonids in the Lower Columbia River	Complementary study of predation by birds downstream from area covered by 9007700.
9702600	Identify Marine Fish Predators of Salmon and Estimate Predation Rates	Complementary study of predation by marine animals.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1993	Initial index of northern pikeminnow predation on juvenile salmonids completed.	Yes. Predation found to be significant throughout the lower Columbia and Snake rivers. Results published in peer-review journals.
1993	Sport-reward and dam-angling fisheries found to	Yes. Annual exploitation rates exceeded

	be successful in removing large numbers of northern pikeminnow.	minimum goal of 10%. Results published in peer-review journals.
1997	Confirmation that compensation by northern pikeminnow and other resident fish predators has not occurred.	Yes. No trends in consumption, growth, or reproduction observed. Results accepted for publication in peer-review journals.
1997	Predation on juvenile salmonids by northern pikeminnow reduced from pre-program levels.	Yes. Modeling results (supported by empirical evidence) indicated that annual predation decreased by 38%. Results accepted for publication in peer-review journals.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Decrease predation on juvenile salmonids in the Columbia River basin by implementing a public sport-reward fishery for northern pikeminnow in the lower Columbia and Snake rivers.	a	Implement the public sport-reward fishery for northern pikeminnow in the lower Columbia and Snake rivers (WDFW).
		b	Issue reward payments and prizes to qualifying anglers, and provide associated accounting, reporting, and problem resolution (PSMFC).
2	Decrease predation on juvenile salmonids in the Columbia River basin by implementing angling for northern pikeminnow at lower Columbia and Snake river dams, and by implementing site-specific removal at other areas where they concentrate.	a	Implement angling for northern pikeminnow at lower Columbia and Snake river dams (CRITFC).
		b	Implement site-specific removal of northern pikeminnow from areas where they concentrate (CRITFC).
3	Evaluate effectiveness of northern pikeminnow fisheries in reducing losses of juvenile salmonids to predation.	a	Monitor exploitation rates achieved by program fisheries (ODFW).
		b	Monitor effects of observed exploitation rates on predation by northern pikeminnow and other resident fish (ODFW).
4	Coordinate implementation of the Northern Pikeminnow Management Program.	a	Guide the development of work statements, budgets, biological assessments, and reports (CBFWA).
		b	Coordinate and guide program activities, respond to inquiries about the program, and provide status reports (CBFWA).
5	Provide contractual and fiscal oversight for all components of the Northern Pikeminnow Management Program.	a	Contract the various tasks comprising the program, and provide fiscal oversight to ensure adherence with the approved budget and program objectives and requirements (PSMFC).

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	4/2000	3/2001	Exploitation rate >10% (Objectives 1 and 2 combined)		70.00%
2	4/2000	3/2001	Exploitation rate >10% (Objectives 1 and 2 combined)		15.00%
3	4/2000	3/2001	Estimate of percent reduction in predation		10.00%
4	4/2000	3/2001			3.00%
5	4/2000	3/2001			2.00%
				Total	100.00%

Schedule constraints

Schedule constraints are minor, but are related to yearly flow rates and temperatures in the Columbia and Snake rivers that affect availability of northern pikeminnow to anglers. Biological Opinion guidelines may affect program duration or start date.

Completion date

This program is continuous because it relies on cumulative removals of northern pikeminnow from the population to achieve sustained reduction in predation on juvenile salmonids.

Section 5. Budget

FY99 project budget (BPA obligated): \$3,306,000

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel		%33	1,100,000
Fringe benefits		%12	400,000
Supplies, materials, non- expendable property		%1	45,000
Operations & maintenance		%5	150,000
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	
NEPA costs		%0	
Construction-related support		%0	
PIT tags	# of tags:	%0	
Travel		%7	225,000
Indirect costs		%12	386,000
Subcontractor		%0	
Other	Reward and Prize Fund	%30	1,000,000
TOTAL BPA FY2000 BUDGET REQUEST			\$3,306,000

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount (\$)
		%0	
		%0	
		%0	
		%0	
Total project cost (including BPA portion)			\$3,306,000

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	\$3,405,000	\$3,507,000	\$3,612,000	\$3,720,000

Section 6. References

Watershed?	Reference
<input type="checkbox"/>	Beamesderfer, C.P., D.L. Ward, and A.A. Nigro. 1996. Evaluation of the biological basis for a predator control program on northern squawfish (<i>Ptychocheilus oregonensis</i>) in the Columbia and Snake rivers. <i>Can J. Fish. Aquat. Sci.</i> 53:2898-2908.
<input type="checkbox"/>	Beamesderfer, R.C., and B.E. Rieman. 1991. Abundance and distribution of northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. <i>Trans. Am. Fish. Soc.</i> 120:439-447.
<input type="checkbox"/>	Collis, K., R.E. Beaty, and B.R. Crain. 1995. Changes in catch rate and diet of northern squawfish associated with the release of hatchery-reared juvenile salmonids in a Columbia River reservoir. <i>N. Am. J. Fish. Manage.</i> 15:346-357.
<input type="checkbox"/>	Columbia River Inter-Tribal Fish Commission. 1995. Wy-Kan-Ush-Mi Wa-Kish-Wit ; The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes, Volume 1., Portland, OR.
<input type="checkbox"/>	Friesen, T.A., and D.L. Ward. In Press(a). Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. <i>N. Am. J. Fish. Manage.</i>
<input type="checkbox"/>	Friesen, T.A., and D.L. Ward. In Press(b). Biological characteristics of walleye in relation to sustained removals of northern pikeminnow in the Columbia River. <i>Fish. Res.</i>
<input type="checkbox"/>	Gadomski, D.M., and Hall-Griswold, J.A. 1992. Predation by northern squawfish on live and dead juvenile chinook salmon. <i>Trans. Am. Fish. Soc.</i> 121:680-685.
<input type="checkbox"/>	Independent Scientific Group. 1996. Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem.
<input type="checkbox"/>	Knutsen, C.J., and D.L. Ward. In Press. Biological characteristics of northern pikeminnow in the lower Columbia and Snake rivers before and after sustained exploitation. <i>Trans. Am. Fish. Soc.</i>
<input type="checkbox"/>	Mesa, M.G. 1994. Effects of multiple acute stressors on the predator avoidance ability and physiology of juvenile chinook salmon. <i>Trans. Am. Fish. Soc.</i> 123:786-793.
<input type="checkbox"/>	National Marine Fisheries Service. 1995. Proposed Recovery Plan for Snake River Salmon. U.S. Department of Commerce, National Oceanic and Atmospheric Administration.
<input type="checkbox"/>	Parker, R.M., M.P. Zimmerman, and D.L. Ward. 1995. Variability in biological characteristics of northern squawfish in the lower Columbia and Snake rivers. <i>Trans. Am. Fish. Soc.</i> 124:335-346.
<input type="checkbox"/>	Petersen, J.H. 1994. The importance of spatial pattern in estimating predation on juvenile salmonids in the Columbia River. <i>Trans. Am. Fish. Soc.</i> 123:924-930.
<input type="checkbox"/>	Petersen, J.H., D.M. Gadomski, and T.P. Poe. 1994. Differential predation by northern squawfish (<i>Ptychocheilus oregonensis</i>) on live and dead juvenile salmonids in the Bonneville

	Dam tailrace (Columbia River). <i>Can. J. Fish. Aquat. Sci.</i> 51:1197-1204.
<input type="checkbox"/>	Poe, T.P., H.C. Hansel, S. Vigg, D.E. Palmer, and L.A. Prendergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in the John Day Reservoir, Columbia River. <i>Trans. Am. Fish. Soc.</i> 120:405-420.
<input type="checkbox"/>	Raymond, H.L. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer chinook salmon and steelhead in the Columbia River basin. <i>N. Am. J. Fish. Manage.</i> 8:1-24.
<input type="checkbox"/>	Rieman, B.E., R.C. Beamesderfer, S. Vigg, and T.P. Poe. 1991. Estimated loss of juvenile salmonids to predation by northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. <i>Trans. Am. Fish. Soc.</i> 120:448-458.
<input type="checkbox"/>	Rieman, B.E., and R.C. Beamesderfer. 1990. Dynamics of a northern squawfish population and the potential to reduce predation on juvenile salmonids in a Columbia River reservoir. <i>N. Am. J. Fish. Manage.</i> 10:228-241.
<input type="checkbox"/>	Vigg, S., T.P. Poe, L.A. Prendergast, and H.C. Hansel. 1991. Rates of consumption of salmonids and alternative prey fish by northern squawfish, walleyes, smallmouth bass, and channel catfish in John Day Reservoir. <i>Trans. Am. Fish. Soc.</i> 120:421-438.
<input type="checkbox"/>	Ward, D.L., J.H. Petersen, and J.J. Loch. 1995. Index of predation on juvenile salmonids by northern squawfish in the lower and middle Columbia River, and in the lower Snake River. <i>Trans. Am. Fish. Soc.</i> 124:321-334.
<input type="checkbox"/>	Ward, D.L., and M.P. Zimmerman. In Press. Response of smallmouth bass to sustained removals of northern pikeminnow in the lower Columbia and Snake rivers. <i>Trans. Am. Fish. Soc.</i>
<input type="checkbox"/>	Zimmerman, M.P. In Press. Comparative food habits and piscivory of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia River basin. <i>Trans. Am. Fish. Soc.</i>
<input type="checkbox"/>	Zimmerman, M.P., and R.M. Parker. 1995. Relative density and distribution of smallmouth bass, channel catfish, and walleye in the lower Columbia and Snake rivers. <i>Northwest Sci.</i> 69:19-28.
<input type="checkbox"/>	Zimmerman, M.P., and D.L. Ward. In Press. Index of predation on juvenile salmonids by northern pikeminnow in the lower Columbia river basin from 1994-96. <i>Trans. Am. Fish. Soc.</i>

PART II - NARRATIVE

Section 7. Abstract

The goal of the Northern Pikeminnow Management Program is to reduce predation on juvenile salmonids through sustained harvest of northern pikeminnow. The program is administered by the Pacific States Marine Fisheries Commission (PSMFC), with coordination and technical guidance from the Columbia Basin Fish and Wildlife Authority (CBFWA). Components of the program include a public sport-reward fishery operated by the Washington Department of Fish and Wildlife (WDFW), tribal dam-angling and site-specific fisheries coordinated by the Columbia River Inter-Tribal Fish Commission (CRITFC), and an evaluation of program effectiveness conducted by the Oregon Department of Fish and Wildlife (ODFW). The program directly addresses FWP measures 5.7A.1, and 5.7B.1 through 5.7B.6.

Research conducted from 1983-93 indicated that (1) loss of juvenile salmonids to resident fish predators was significant, (2) northern pikeminnow were responsible for a majority of the losses, and (3) relatively large reductions in predation could be achieved through relatively low exploitation of northern pikeminnow. From 1990-98, over 1.3 million northern pikeminnow were harvested by program fisheries, with annual exploitation since 1991 averaging approximately 12%. From 1991-98, the minimum goal of 10% exploitation was exceeded in 6 of 8 years. Modeling results indicate that annual losses of juvenile salmonids to northern pikeminnow have decreased approximately 38% from pre-program levels. Empirical evidence supports these results. There is no evidence of compensation in predation, growth, or

reproduction by surviving northern pikeminnow, or by other resident fish predators. If the program continues to achieve >10% annual exploitation, benefits will be maintained or increased. Exploitation will continue to be monitored annually, which will result in annual estimates of reductions in predation. Direct monitoring of program effects on predation, through collection of data on predation by and population dynamics of northern pikeminnow and other resident predators, will be conducted every three years.

Section 8. Project description

a. Technical and/or scientific background

Unlike many predator control programs, the Northern Pikeminnow Management Program (NPMP) is based on sound science and in-depth knowledge of the situation: (1) development of the Columbia River basin hydrosystem has increased predation on out-migrating juvenile salmonids, (2) northern pikeminnow *Ptychocheilus oregonensis* are responsible for the overwhelming majority of the predation, (3) population dynamics and behavior of northern pikeminnow facilitate relatively large reductions in predation from relatively low exploitation, and (4) compensation by surviving northern pikeminnow or other predators is unlikely.

Development of the hydropower system in the Columbia River basin has resulted in increased losses of juvenile salmonids to resident fish predators. At dams, migrating juvenile salmonids are concentrated in forebays and tailraces, causing increased predation and salmonid loss (Poe et al. 1991; Vigg et al. 1991; Ward et al. 1995). Migration past dams also causes injury and physiological stress, which may increase the vulnerability of salmonids to predators (Mesa 1994). Impoundments enhance populations of resident predatory fish (Zimmerman and Parker 1995), and increase travel time for migrating juvenile salmonids, prolonging their exposure to predators (Raymond 1988; Poe et al. 1991).

Rieman et al. (1991) estimated a mean annual loss of 2.7 million juvenile salmonids to predation by northern pikeminnow, walleye *Stizostedion vitreum*, and smallmouth bass *Micropterus dolomieu* in John Day Reservoir from 1983-86. Northern pikeminnow were responsible for 78% of the loss, or 2.1 million juvenile salmonids annually. Petersen (1994) revised this estimate to approximately 1.4 million juvenile salmonids (7% of the run) based on spatial patterns of predation. Ward et al. (1995) developed an index of northern pikeminnow predation, and estimated that annual losses from 1990-93 relative to the estimate for John Day Reservoir were 808% downstream from Bonneville Dam, 275% in Bonneville plus The Dalles reservoirs, 50% in McNary Reservoir, 98% in Columbia River reservoirs upstream from the Snake River, and 37% in the four lower Snake River reservoirs. These index values would translate into 16.4 million juvenile salmonids consumed annually by northern pikeminnow, or 8% of the approximately 200 million hatchery and wild juvenile salmonid outmigrants in the Columbia River system (Beamesderfer et al. 1996).

Estimates of predation losses were relatively unbiased by consumption of juvenile salmonids killed by dam passage. Most salmonids consumed by northern pikeminnow were eaten alive, despite observed preferences for dead salmonids in laboratory and field tests (Gadomski and Hall-Griswold 1992; Petersen et al. 1994). Petersen et al. (1994) marked and released dead and live salmonids into a dam tailrace in a 10% dead proportion that simulated turbine mortality rate and observed that 22% of marked salmonids subsequently recovered from northern pikeminnow were dead before release. If dead fish constitute 22% of northern pikeminnow prey near a dam, dam effects extend 10 km upstream and downstream, and 69% of predation occurs in that zone (Petersen 1994), then 85% of the estimated predation would be on live fish ($1 - (0.69 \times 0.22)$).

Unlike walleye and smallmouth bass, population dynamics and behavior of northern pikeminnow indicate that reductions in predation through a removal program are feasible. Northern pikeminnow are long-lived and slow-growing, and become increasingly piscivorous with age (Poe et al. 1991; Parker et al. 1995). Salmonids are generally an important diet component only for large, old individuals (Vigg et al. 1991), and consumption rates of juvenile salmonids by northern pikeminnow increase exponentially as size increases (Beamesderfer et al. 1996). Coincidentally, northern pikeminnow vulnerability to most fishing gears also increases with size (Friesen and Ward In Pressa). Rieman and Beamesderfer (1990) used simulation

models to estimate that sustained annual exploitation of 10-20% of northern pikeminnow >250 mm fork length would reduce predation by northern pikeminnow by 50%. The primary control mechanism is the cumulative effect of exploitation, which systematically reduces the number of older piscivorous individuals through time. Based on changes in the population structure of northern pikeminnow, Friesen and Ward (In Pressa) estimate that as a result of northern pikeminnow harvest since 1990, predation on juvenile salmonids by northern pikeminnow has been reduced by approximately 38% annually.

Rieman and Beamesderfer (1990) concluded that compensation by surviving northern pikeminnow was unlikely because (1) fecundity is much lower than fecundity of species considered resilient, (2) growth is slow and mortality low compared with other species, and (3) density-dependent growth was not obvious. Knutsen and Ward (In Pressb) have confirmed that northern pikeminnow compensation has not occurred. Friesen and Ward (In Pressb) and Ward and Zimmerman (In Press) have confirmed that compensation by walleye and smallmouth bass has not occurred.

b. Rationale and significance to Regional Programs

The NPMP will contribute to the FWP goals of doubling fish runs while maintaining biological diversity, and providing a healthy Columbia River basin that supports human settlement and long-term sustainability of native fish. Reduced predation will lead to increased survival of both wild and hatchery juvenile salmonids from numerous subbasins, which may then contribute to increased returns of adults. Therefore, reduction in predation by northern pikeminnow is specifically called for under Measures 5.7A and 5.7B of the FWP.

Objectives 1 and 2 of the NPMP, the implementation of northern pikeminnow fisheries, are directly related to FWP measures 5.7A.1 (reduce pikeminnow population by more than 20% in the Snake and Columbia rivers), and 5.7B.1 (continue implementation of the current pikeminnow project). Objective 3, evaluation of the project, is directly related to FWP measures 5.7B.2 (document population dynamics, life history, and behavior of pikeminnow to monitor responses of populations to control measures), 5.7B.3 (monitor program effectiveness, monitor exploitation rates, age structures, etc.), and 5.7B.4 (assess effects of pikeminnow control on other salmon predators).

The NPMP is also a component of the NMFS Proposed Recovery Plan for Snake River Salmon, and *Wy-Kan-Ush-Mi Wa-Kish-Wit*, the anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs, and Yakama tribes. Task 2.8 of the NMFS plan is to reduce loss of listed species to predation and competition. Task 2.8.a.1 calls for continuation of the NPMP. *Wy-Kan-Ush-Mi Wa-Kish-Wit* recommends continued evaluation of intensive removal of northern pikeminnow.

The NPMP does not mitigate for losses of juvenile salmonids; rather, it prevents losses. A 38% reduction in annual losses to predation by northern pikeminnow equates to saving more than 6 million juvenile salmonids annually. If the project is not continued, predation will increase each year until levels observed prior to implementation are reached. The potential consequence of stopping the project is therefore the loss of 6 million juvenile salmonids annually, a significant portion of the total run. This includes stocks listed as threatened or endangered; therefore, this consequence is unacceptable.

c. Relationships to other projects

The NPMP is a component of the *Mainstem Columbia River Umbrella Proposal*. One of the objectives of the umbrella is to increase returns of hatchery and naturally produced salmonids to the Columbia River basin, and one of the strategies to meet this objective is to decrease predation on juvenile salmonids. This strategy corresponds to the overall goal of the NPMP, and is specifically addressed by objectives 1 and 2 of the NPMP.

The NPMP is the only project conducting field activities designed to reduce predation on juvenile salmonids by resident fish. As such, it is not dependent on any other project. Other projects evaluating predation on juvenile salmonids include project 9702600, *Identify Marine Fish Predators of Salmon and*

Estimate Predation Rates, and project 9702400, *Avian Predation on Juvenile Salmonids in the Lower Columbia River*. Project 9007800, *Evaluate Predator Control and Provide Technical Support for PATH*, independently tests the hypothesis that removal of northern pikeminnow does not cause compensatory feeding by predators that remain in the system. Data collected as part of the evaluation component of the NPMP are shared with Project 9007800, and staff from the two projects meet occasionally to discuss similarities or differences in analyses and findings.

d. Project history (for ongoing projects)

History

The NPMP began in 1990, based on findings from the earlier work conducted in John Day Reservoir (Poe et al. 1991; Vigg et al. 1991; Beamesderfer and Rieman 1991; Rieman et al. 1991), and on the potential for successful predation management (Rieman and Beamesderfer 1990). Although the project number has not changed, the project was originally titled *Development of a System-Wide Predator Control Program: Stepwise Implementation of a Predation Index, Predator Control Fisheries, and Evaluation Plan in the Columbia River Basin*. Overall objectives of the project were to (1) determine the significance of predation in Columbia River reservoirs through implementation of indexing of predator abundance and integration with consumption indices, (2) implement a predator control fishery development plan, beginning with a test fishery in John Day Reservoir in 1990, and (3) initiate an evaluation of the Predator Control Program.

Predation Index-Initial predation indexing was conducted from 1990-93 by the ODFW, the National Biological Service (NBS), and the WDFW. Estimates of absolute predation, comparable to the estimates made for John Day Reservoir (Rieman et al. 1991), would have been prohibitive in cost and time for a system of multiple reservoirs. Therefore, a predation index was developed to describe the relative magnitude of northern pikeminnow predation on juvenile salmonids. The predation index was the product of an abundance index developed by ODFW and a consumption index developed by NBS. Both indices were highly correlated with direct estimates (Ward et al. 1995).

Indexing was conducted in lower Columbia River reservoirs (1990), lower Snake River reservoirs (1991), downstream from Bonneville Dam (1992), and in mid-Columbia River reservoirs (1993). Indexing was conducted prior to significant removals of northern pikeminnow in each area (Parker et al. 1995). John Day Reservoir was sampled each year to compare results with other areas and to examine annual variability. Results from indexing indicated that annual losses of juvenile salmonids from predation by northern pikeminnow relative to the estimate for John Day Reservoir were 808% downstream from Bonneville Dam, 275% in Bonneville plus The Dalles reservoirs, 50% in McNary Reservoir, 98% in Columbia River reservoirs upstream from the Snake River, and 37% in the four lower Snake River reservoirs (Ward et al. 1995).

Predator Control Fisheries-Test fisheries for northern pikeminnow initiated in John Day Reservoir in 1990 included a public sport-reward fishery, a tribal long-line fishery, and an agency-operated dam-angling fishery (John Day and McNary dams). The dam-angling fishery was also conducted at Bonneville, The Dalles, and Ice Harbor dams. The success of the sport-reward fishery (4,681 northern pikeminnow) led to implementation of the fishery throughout the lower Columbia and Snake rivers in 1991. The reward was set at \$3 per northern pikeminnow >11 inches total length, which is similar to 250 mm fork length. Dam-angling was also successful in 1990 (11,005 fish), leading to implementation at the four lower Columbia River dams and the four lower Snake River dams in 1991. The long-line fishery (1,420 fish) was expanded to include Bonneville and The Dalles reservoirs in 1991.

The long-line fishery was discontinued after 1991 due to lack of participation. Other technologies for removal of northern pikeminnow were tested from 1990-93, including lure trolling, purse seining, electrofishing, trap-netting, and commercial long-lining; however, none proved effective. In 1994, a site-specific gillnet fishery to remove northern pikeminnow near hatchery release points and tributary mouths was implemented and considered successful (9,018 fish). Implementation of new test fisheries was discontinued after 1994, leaving sport-reward, dam-angling, and site-specific fisheries as the methods of northern pikeminnow removal.

Since 1990, over 1.3 million northern pikeminnow have been removed from the lower Columbia and Snake rivers, with annual exploitation since 1991 averaging approximately 12% of fish >250 mm fork length (Friesen and Ward In Pressa):

	Sport Reward		Dam Angling		Site Specific		Other	
1990	4,681	(--)	11,005	(--)	--	(--)	1,648	(--)
1991	153,508	(8.5%)	39,196	(2.2%)	--	(--)	7,366	(--)
1992	186,095	(9.3%)	27,442	(2.7%)	--	(--)	8,766	(--)
1993	104,536	(6.8%)	17,105	(1.3%)	--	(--)	3,460	(--)
1994	129,384	(10.9%)	15,938	(1.1%)	9,018	(1.2%)	--	(--)
1995	199,788	(13.4%)	5,397	(0.3%)	9,484	(1.9%)	--	(--)
1996	157,230	(12.1%)	5,381	(0.3%)	6,167	(0.5%)	--	(--)
1997	119,047	(8.8%)	3,517	(0.1%)	2,806	(0.5%)	--	(--)
1998	108,372	(11.1%)	3,175	(0.1%)	3,035	(0.3%)	--	(--)

Evaluation of the Program-Evaluation of the program consists of (1) monitoring the exploitation rate and size of northern pikeminnow harvested annually for each fishery, and (2) monitoring the effects of observed exploitation rates on predation. Monitoring the effects of exploitation includes (1) comparing predation indices before and after sustained implementation of the program, (2) describing the response of northern pikeminnow to sustained removals, and (3) describing the response of other predators (walleye and smallmouth bass) to sustained removals of northern pikeminnow.

As shown in the table above, annual exploitation rates since 1991 have averaged about 12% of northern pikeminnow >250 mm fork length, and the minimum goal of 10% exploitation has been met or exceeded in 6 of 8 years. All fisheries target large, piscivorous northern pikeminnow, with mean fork lengths of 346 mm in the sport-reward fishery, 401 mm in the dam-angling fishery, and 409 mm in the site-specific fishery (Friesen and Ward In Pressa). Exploitation will continue to be monitored annually.

Predation by northern pikeminnow was indexed throughout the lower Columbia and Snake rivers each year from 1990-96. Indices of predation were consistently lower from 1994-96 than from 1990-93 (Zimmerman and Ward In Press). Piscivory by surviving northern pikeminnow has not increased since implementation of the program (Zimmerman In Press). Predation will now be indexed every three years, beginning in 1999.

Size structure of northern pikeminnow populations has decreased with sustained removals of large fish; however, no compensation in reproduction or growth has been observed (Knutsen and Ward In Press). Similarly, no trends of increased predation, reproduction, or growth of walleye or smallmouth bass have been observed (Friesen and Ward In Pressb; Ward and Zimmerman In Press; Zimmerman In Press). We will continue to collect information on population dynamics of northern pikeminnow, walleye, and smallmouth bass concurrent with predation indexing.

Modeling results indicate that if all variables other than exploitation of northern pikeminnow were held constant, annual predation by northern pikeminnow on juvenile salmonids has decreased to 62% (range 45-75%) of pre-program levels (Friesen and Ward In Pressa). Empirical estimates of northern pikeminnow predation (Zimmerman and Ward In Press) support results from modeling. Lack of response by surviving northern pikeminnow and other predators increases confidence in the hypothesis that sustained removals of northern pikeminnow increases survival of juvenile salmonids. We will continue to estimate predation losses annually.

Reports and Technical Papers

Annual reports have been published for each year's work since 1990. Following the author(s) and year (which are listed below), the correct citation of each report is "Development of a system-wide predator control program: stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River basin. Annual Report to Bonneville Power Administration, Contract No. DE-

B179-90BP07084, Portland, Oregon.” The contract number changed to 94BI24514 with Willis and Young (1995).

Nigro, A. A. 1990.

Willis, C. F., and A. A. Nigro. 1993.

Willis, C. F., D. L. Ward, and A. A. Nigro. 1994.

Willis, C. F., and D. L. Ward. 1995.

Willis, C. F., and F. R. Young. 1995.

Young, F. R. 1997

Young, F. R. 1998.

A report summarizing findings of the program evaluation from 1990-96 has also been completed:

Ward, D. L. 1998. Evaluation of the northern squawfish management program, final report of research, 1990-96. Final Report to Bonneville Power Administration, Contract Nos. DE-B179-90BP07084 and 94BI24514, Portland, Oregon.

The following list of peer-review journal articles produced as part of the program are cited completely in Section 6 (References) of Part I. Papers cited as In Press have been accepted for publication. Copies of these papers are available from David Ward, ODFW (503) 657-2000 Ext. 402.

Beamesderfer, C. P., D. L. Ward, and A. A. Nigro. 1996

Collis, K., R. E. Beaty, and B. R. Crain. 1995.

Friesen, T. A., and D. L. Ward(a). In Press.

Friesen, T. A., and D. L. Ward(b). In Press.

Knutsen, C. J., and D. L. Ward. In Press.

Parker, R. M., M. P. Zimmerman, and D. L. Ward. 1995.

Ward, D. L., J. H. Petersen, and J. J. Loch. 1995.

Ward, D. L., and M. P. Zimmerman. In Press.

Zimmerman, M. P. In Press.

Zimmerman, M. P., and D. L. Ward. In Press.

Zimmerman, M. P., and R. M. Parker. 1995.

Summary of Major Results

Major results have been explained in detail in the *History* subsection above. To summarize:

- (1) Predation on juvenile salmonids by northern pikeminnow was indexed throughout the lower and mid Columbia River and the lower Snake River from 1990-93, with results confirming that significant losses of juvenile salmonids occurred throughout the basin.
- (2) Fisheries for northern pikeminnow, which were started in John Day Reservoir on a test basis in 1990, have resulted in the removal of over 1.3 million northern pikeminnow >250 mm fork length throughout the lower Columbia and Snake rivers, with annual exploitation from 1991-98 averaging approximately 12%.
- (3) Sampling from 1990-96 confirmed that compensation in predation, growth, or reproduction by surviving northern pikeminnow and other resident fish predators has not occurred.
- (4) Predation indices from 1994-96 were lower than those from 1990-93, and estimates of annual predation by northern pikeminnow on juvenile salmonids have decreased to 62% (range 45-75%) of pre-program levels.

Adaptive Management Implications

Development of the northern pikeminnow fisheries was based on adaptive management. Numerous techniques to harvest northern pikeminnow were tested from 1990-93, but only the most successful were continued. Lure trolling, purse seining, electrofishing, trap-netting, and tribal and commercial long-line

fisheries were all discontinued because they were not able to harvest significant numbers of northern pikeminnow.

Success of the continuing fisheries has also relied on adaptive management. The sport-reward fishery was relatively unsuccessful in 1990 until the reward was raised from \$1 to \$3 per northern pikeminnow. Implementation of a tiered reward system in 1995, based on total number of fish caught, resulted in increased participation in the fishery. Number and locations of registration stations for the sport-reward fishery have also changed over the years, depending on trends in effort and catch. Current locations of the stations maximize the efficiency of the fishery.

The dam-angling and site-specific fisheries have utilized adaptive management to maximize catches while decreasing costs. Dam angling is concentrated in tailraces of the dams where catch per effort is highest. The site-specific fishery is also concentrated in areas where catch per effort is highest.

Years Underway and Past Costs

1990	\$1,421,813
1991	\$5,259,629
1992	\$6,846,410
1993	\$4,253,600
1994	\$3,670,707
1995	\$4,311,186
1996	\$3,846,248
1997	\$3,730,347
1998	\$3,259,230
1999	\$3,306,000

e. Proposal objectives

- (1) Decrease predation on juvenile salmonids in the Columbia River basin by implementing a public sport-reward fishery for northern pikeminnow in the lower Columbia and Snake rivers.
- (2) Decrease predation on juvenile salmonids in the Columbia River basin by implementing angling for northern pikeminnow at lower Columbia and Snake river dams, and by implementing site-specific removal from other areas where they concentrate.
- (3) Evaluate effectiveness of northern pikeminnow fisheries in reducing losses of juvenile salmonids to predation.
- (4) Coordinate implementation of the Northern Pikeminnow Management Program.
- (5) Provide contractual and fiscal oversight for all components of the Northern Pikeminnow Management Program.

The goal of the program is to reduce hydrosystem-exacerbated predation on juvenile salmonids by northern pikeminnow. Extensive research in the Columbia River basin indicated that sustained removals of northern pikeminnow at a relatively low rate (Objectives 1 and 2) would result in a disproportionate reduction in predation. Evaluation of the program (Objective 3) has shown that target exploitation rates (>10%) are feasible to sustain, and that predation by northern pikeminnow has been reduced to approximately 62% (range 45-75%) of pre-program levels. Evaluation has also confirmed the lack of compensation by surviving northern pikeminnow and other resident fish.

f. Methods

Objective 1 (Sport-reward fishery)

Task 1a is the implementation of the public sport-reward fishery by the WDFW. This fishery occurs in the mainstem Columbia River from its mouth to Priest Rapids Dam, and in the mainstem Snake River from its mouth to Hells Canyon Dam. The fishery utilizes registration sites located strategically throughout the lower Columbia and Snake rivers to register participants. Location of the registration sites is based on analysis of effort and catch in the fishery from 1991-98, and on results from indexing the relative abundance of northern pikeminnow (Ward et al. 1995; Zimmerman and Ward In Press). Sites are open 7 days a week from 1PM to 9PM from early May through late September. Anglers are permitted to self-register when sites are not open. In addition to registration sites, various satellite sites located in remote areas where fishing effort warrants their use are operated for two hours each day.

The reward paid to successful anglers is \$4 per qualifying northern pikeminnow for the first 100 fish caught in the season, \$5 for each fish from 101-400, and \$6 per fish when catch exceeds 400. Fish must be at least 11 inches total length (similar to 250 mm fork length) to qualify for payment. Fish are collected and disposed of through rendering services by the PSMFC. The angler is issued a voucher when presenting fish for payment. The angler mails vouchers to PSMFC for processing. PSMFC mails a check to the angler and maintains records to determine the proper reward based on the tiered payment structure (Task 1b). A detailed incentive and promotional plan has been developed (Task 4b) and is implemented each year to maximize fishing effort. Effectiveness of the promotional plan is evaluated each year (Tasks 4b and 5a).

The short-term result expected from the fishery is the harvest of northern pikeminnow >250 mm fork length. From 1990-98, nearly 1.2 million northern pikeminnow were harvested by the sport-reward fishery. Expected long-term results include reductions in predation on juvenile salmonids through reductions in the number of older piscivorous northern pikeminnow.

Objective 2 (Dam-angling and site-specific fisheries)

Task 2a is implementation of the dam-angling fishery by the CRITFC and Treaty Tribes. The purpose of dam-angling is to remove northern pikeminnow from areas that have (1) no public access, and (2) historically high rates of predation. Crews are hired to angle and may work with volunteers to fish at the four lower Columbia River and the four lower Snake River dams. Roving crews fish from May through September, and are deployed where effort is most effective.

CRITFC and Treaty Tribes also conduct the site-specific fishery (Task 2b). Crews are hired to fish with gill nets and hook and line near hatchery release sites and tributary mouths where northern pikeminnow concentrate. The site-specific fishery is concentrated in areas of high catch per effort from 1994-98. The fishery is implemented in conjunction with and in close coordination with the dam-angling fishery to minimize costs.

Short and long-term results are similar to those of the sport-reward fishery. From 1990-98, the dam-angling fishery removed over 128,000 northern pikeminnow. From 1994-98, the site-specific fishery removed over 30,000 northern pikeminnow.

Objective 3 (Evaluation of the program)

Evaluation of the program is conducted by the ODFW. ODFW monitors exploitation rates achieved by the fisheries annually (Task 3a). Each year before the fisheries begin, ODFW conducts electrofishing and sets gill nets throughout the lower Columbia and Snake rivers to capture, tag, and release northern pikeminnow. Tags are recovered when anglers turn in fish for payment. A return rate of 100% is assumed because anglers receive \$50 for returning tagged fish. Numbers of fish tagged and released each year have varied from approximately 1,400 to over 3,000, depending on river conditions and variations in northern pikeminnow abundance. Sample sizes are adequate, because the number of northern pikeminnow subsequently captured and examined for tags has ranged from approximately 115,000 to over 200,000, depending on the catch in the fisheries. Lower and upper 95% confidence limits on estimates of system-wide exploitation from 1991-97 have averaged 69% (range 52-81%) and 164% (range 148-203%) of the

point estimate. Specific details of sampling methods and analyses used to estimate exploitation are given in Friesen and Ward (In Pressa).

ODFW also monitors the effects of observed exploitation on predation by northern pikeminnow and other resident fish (Task 3b). From 1990-93 ODFW, WDFW, and the NBS sampled throughout the lower Columbia and Snake rivers to index predation on juvenile salmonids by northern pikeminnow (Ward et al. 1995), and collect information on northern pikeminnow, walleye, and smallmouth bass population structure, growth, and reproduction (Parker et al. 1995; Zimmerman and Parker 1995). ODFW continued annual sampling from 1994-96 to compare pre-program predation indices and population dynamics to those after years of sustained removals (Friesen and Ward In Pressb; Knutsen and Ward In Press; Ward and Zimmerman In Press; Zimmerman In Press; Zimmerman and Ward In Press).

Annual monitoring of predation and population dynamics was discontinued after 1996. Findings indicated that predation had decreased (Zimmerman and Ward In Press), and that northern pikeminnow and other resident fish had not compensated for sustained removals (Friesen and Ward In Pressb; Knutsen and Ward In Press; Ward and Zimmerman In Press). Predation indexing and population monitoring will now be conducted every three years, the first of which is 1999.

Modeling results (Friesen and Ward In Pressa), which indicate a 38% reduction in annual predation by northern pikeminnow, have been confirmed by empirical evidence (Zimmerman and Ward In Press). Annual exploitation estimates will continue to be used to generate annual estimates of reductions in predation.

g. Facilities and equipment

The facilities being used for the program include agency offices for: Pacific States Marine Fisheries Commission, Gladstone, OR; Columbia Basin Fish and Wildlife Authority, Portland, OR; Washington Department of Fish and Wildlife, Olympia, Vancouver, North Bonneville, and Pasco, WA; Oregon Department of Fish and Wildlife, Clackamas, OR; Columbia River Inter-Tribal Fish Commission, Portland, OR; Yakama Indian Nation, Toppenish, WA; Nez Perce Tribe, Lapwai, ID; Confederated Tribes of the Warm Springs Reservation, Warm Springs, OR; and Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR. These facilities are all suitable for program needs relating to office, laboratory, and storage needs.

All capital equipment for the program is currently on hand from previous expenditures. This includes computers at all of the offices to process and transmit data, boats, motors, and trailers for field operations, and fish handling equipment. All computers have Pentium processors, and are capable of processing large data sets. Software used for data analyses include SAS, Sigmaplot, and Microsoft Excel. Current computer costs are limited to occasional replacements and upgrades of hardware and software.

Vehicles used in the program include approximately 22 vans, trucks, and cars used to help operate registration sites, conduct tribal fisheries, and evaluate all fisheries. Boats include two Boston Whalers and two electrofishing boats used by ODFW for evaluation tasks.

h. Budget

The total proposed budget (\$3,306,000) is identical to the budget for FY 1999 (\$3,306,000). Evaluation activities are reduced from those in 1999, and will not be increased again until 2002 (predation indexing and population monitoring are conducted every three years); however, increases in salaries and indirect costs by project cooperators have offset this reduction.

Section 9. Key personnel

Russell G. Porter

Pacific States Marine Fisheries Commission
45 S.E. 82nd Dr., Suite 100
Gladstone, OR 97027

Education

University of California (Berkeley) B.A., Zoology, 1962
California State University (Humboldt) M.S., Fisheries, 1964
Certified Fisheries Scientist, American Fisheries Society, 1968

Experience

1977-Present: Pacific States Marine Fisheries Commission, Field Programs Administrator.
Coordination of all field programs utilizing Commission employed field samplers and serves as contact for field programs where Commission member states work as partners with PSMFC on field data collection projects. Current and recent projects include: Northern Pikeminnow Management Program - Fiscal and Contractual Administrator (1993-date); Pacific Coast (CA, OR & WA) Marine Recreational Fisheries Statistics Survey - Principal Investigator; Recreational Fisheries Information Network [Coastwide marine sportfish database of catch and effort] - Project Manager; Coastwide commercial albacore, catch, effort and biological sampling - COTR (1984-date); Northwest Emergency Assistance Program [Salmon Disaster Relief] Data Collection Program for at-sea research on hooking mortality, coho/chinook encounter rates and gear selectivity studies - Program Manager (1994-date).

University of Washington: Lecturer, College of Fisheries - Fisheries Hydrology Course (1976) Teaching Assistant: Fisheries Hydrology/Engineering Course (9 Semesters)

Milo C. Bell Inc.: Environmental and fisheries consulting for hydroelectric projects, pipeline river crossings, culverts, fishway and fish hatchery design, power plant intake and screening, and fish passage problems. Major clients included: U.S. Army Corps of Engineers, National Marine Fisheries Service, Portland General Electric, Idaho Power and Light, Douglas and Chelan County PUD's, Consumers Power (Michigan), Arizona Public Service Co., Edison International, EPA, Washington Water Research Center, various Northwest Treaty Tribes, El Paso Gas Co., and Weyerhaeuser, Inc.

U.S. Navy: Commissioned Officer on Active duty 1964-1969. Instructor of Oceanography, Meteorology, Celestial & Marine Navigation U.S. Naval Academy(1966-1969), Graduate U.S. Naval Justice School; Commanding Officer U.S. Naval Reserve Oceanographic Unit (Seattle) - (1976-77); Graduate Combat Information Center Officer School (San Diego), LCDR, USNR-retired.

Numerous scientific publications, twenty years of field project management, fisheries management committees, design of scientific studies, and preparation of proposals for research projects on salmon and marine species.

John S. Hisata

Washington Department of Fish and Wildlife
600 Capitol Way North,
Olympia, Washington 98501 - 1091

Education

University of Washington (Seattle)

B.S., Fisheries, 1969

Major studies in Invertebrate Fisheries

Experience

1981-Present: Washington Department of Fish and Wildlife, Resident Native Fish Program Assistant, Project Manager, Northern Pikeminnow Sport-Reward Fishery, (1994-Present). Regional Fisheries Resource Manager, (1981-94).

Expertise and Accomplishments

Experience as manager of a multi-species regional fisheries program through direction of fisheries biologists and hatchery managers as the Regional Fisheries Resource Manager for the WDFW Region One in Spokane, Washington. This Region was one of six in the state. In this position, I directed the development of the steelhead program at the Lyons Ferry Hatchery on the Snake River, and the initial development of the kokanee program at the Sherman Creek Hatchery on Lake Roosevelt. Prior to this, I developed the Department's initial coded wire tag recovery efforts on the Columbia River Tag Recovery Project in 1978 through 1980.

Keith Martin Hatch
Columbia River Inter-Tribal Fish Commission
729 N.E. Oregon, Suite 200
Portland, OR 97232
Phone 503-731-1303

Education

Oregon State University (Corvallis)	M.S., Fisheries, 1990
Oregon State University (Corvallis)	B.S., Biology, 1980

Experience

Columbia River Inter-Tribal Fish Commission, Project Leader, Northern Pikeminnow Management Program: Supervise the CRITFC project staff. Coordinate the fishing efforts, data handling and reporting of four tribal contractors. Previously, fishery scientist on the Gas Bubble Trauma project and the StreamNet Information System (Responsible for coordinating the five volume interstate stock summary report project).

U.S. Fish and Wildlife Service, Fisheries Assistance Office, Vancouver, Fisheries Management Biologist: Service representative to the TAC, OPI and AFPC committees. Management and interpretation of harvest, effort, test fishing, environmental and dam passage data for the management of Columbia River salmonids. This included run size prediction, cohort, coded wire tag and scale analyses. Field work included instream flow, redd counts, estuary surveys, hatchery spawning, electrofishing, & adult trap operation.

Oregon Cooperative Fisheries Research, Corvallis: Unit collections and electrophoretic analysis. Multivariate analysis, writing of quarterly reports and delivery of results at professional meetings.

Oregon Natural Resources Council, Fisheries Researcher: Finding and cataloging fisheries information for selected Oregon roadless areas proposed for wilderness protection. Production of brochures and magazine articles.

O.S.U. Dept. of Fish and Wildlife, Foreign Fisheries Observer: Collecting of biological data in the Gulf of Alaska and the Bering Sea aboard Japanese longline fishing vessels.

David Ward

Oregon Department of Fish and Wildlife
17330 S.E. Evelyn Street
Clackamas, OR 97015

Education

Humboldt State University (Arcata, CA)	M.S. Fisheries, 1985
Humboldt State University (Arcata, CA)	B.A. Zoology, 1978

Experience

1984-Present: Oregon Department of Fish and Wildlife, 17330 S.E. Evelyn St., Clackamas, OR. (1) Program Leader for Northwest Region Research Program (1998-Present): Coordinate activities of ongoing departmental and interagency projects, identify needs for and develop future projects, provide technical oversight to project leaders, and supervise project leaders and other program staff. (2) Project Leader: Evaluation of the Northern Pikeminnow Management Program (1991-98). (3) Project Leader: Portland Harbor Study (1988-91). (4) Project Biologist and Technician on various studies (1984-87).

Expertise

Coordinated and integrated activities of cooperating agencies, hired and supervised staff of project leaders, project biologists, and seasonal workers, designed field and laboratory sampling plans, analyzed wide variety of biological data, authored, edited, and reviewed scientific reports and peer-review articles. Organized personnel from cooperating agencies to give symposia at fisheries conferences. Developed and submitted proposals for numerous research projects to various funding sources. Direct experience with methods and gears associated with habitat and fish surveys in streams, rivers, lakes, and reservoirs.

Publications and Reports

- Ward, D.L., and M.P. Zimmerman. In Press. Response of smallmouth bass to sustained removals of northern pikeminnow in the lower Columbia and Snake rivers. Transactions of the American Fisheries Society.
- Friesen, T.A., and D.L. Ward. In Press(a). Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. North American Journal of Fisheries Management.
- Zimmerman, M.P., and D.L. Ward. In Press. Index of predation on juvenile salmonids by northern pikeminnow in the lower Columbia river basin from 1994-96. Transactions of the American Fisheries Society.
- Beamesderfer, R.C., D.L. Ward, and A.A. Nigro. 1996. Evaluation of the biological basis for a predator control program on northern squawfish in the Columbia and Snake rivers. Canadian Journal of Fisheries and Aquatic Sciences 53:2898-2908.
- Ward, D.L., J.H. Petersen, and J.J. Loch. 1995. Index of predation on juvenile salmonids by northern squawfish in the lower and middle Columbia River and in the lower Snake River. Transactions of the American Fisheries Society 124:321-334.

Mark Zimmerman
Oregon Department of Fish and Wildlife
17330 S.E. Evelyn Street
Clackamas, OR 97015

Education:

Virginia Tech (Blacksburg, VA)	M.S. Fisheries Science, 1989
Virginia Commonwealth U. (Richmond, VA)	M.S. Biology, 1984
Moravian College (Bethlehem, PA)	B.S. Biology, 1979

Experience:

1990-Present Oregon Department of Fish and Wildlife, 17330 S.E. Evelyn St., Clackamas, OR. (1) Project Leader for Evaluation of Northern Pikeminnow Management Program (1 yr): Plan, coordinate, and implement field sampling and laboratory analyses, conduct data analyses, and prepare oral and written scientific reports. (2) Assistant Project Leader: Evaluation of Northern Pikeminnow Management Program (5 yr, 11 mo). (3) Research Biologist: Process to Analyze and Test Hypotheses. (3 months). (4) Project Leader: Smolt Monitoring at Little Goose Dam and lower Grande Ronde River (6 months);

Expertise: Coordinated project activities with cooperating agencies, designed field and laboratory sampling plans, hired and supervised project biologists and seasonal personnel, analyzed wide variety of biological data, authored oral and written scientific reports and peer reviewed articles. Direct experience with methods and gears associated with habitat and fish surveys in streams, rivers, lakes, and reservoirs. Developed and submitted research project proposals to various funding sources.

Publications and Reports:

Zimmerman, M.P. October 27, 1998. An overview of Columbia River predation studies. Workshop: Management Implications of Co-occurring Native and Introduced Fishes. National Marine Fisheries Service and Oregon Department of Fish and Wildlife, Portland, Oregon.

Zimmerman, M.P. In Press. Comparative food habits and piscivory of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia River basin. Transactions of the American Fisheries Society.

Zimmerman, M.P., and D.L. Ward. In Press. Index of predation on juvenile salmonids by northern pikeminnow in the lower Columbia River basin from 1994-96. Transactions of the American Fisheries Society.

Zimmerman, M.P., T. Hillson, and R.R. Boyce. 1996. Smolt monitoring activities at Little Goose Dam in 1993 and 1994, and smolt travel-time analysis, 1992-94. Annual progress report. Oregon Department of Fish and Wildlife, Portland, Oregon.

Zimmerman, M.P., and R.M. Parker. 1995. Relative density and distribution of smallmouth bass, channel catfish, and walleye in the lower Columbia and Snake rivers. Northwest Science 69: 19-28.

Section 10. Information/technology transfer

Monthly meetings of all project participants are held to review progress and results as well as to coordinate ongoing work. This provides opportunities to transmit data to agency managers when appropriate.

Annual reports summarizing each year's activities and results are published by BPA. Special reports summarizing evaluation results are periodically published by BPA. The most recent of these was a report summarizing 1990-96 results (Ward 1998).

Evaluation results have also been published in scientific journals. To date, 11 papers directly resulting from the project have been published or accepted for publication in peer-review journals (see list in Section 7d).

Project personnel also participate in symposia and workshops. The 1997 annual meeting of the American Fisheries Society included a session dedicated to predation studies in the Columbia River basin. The

session was organized by project personnel. Findings from the project were also presented at the 1998 workshop “Management Implications of Co-occurring Native and Introduced Fishes”, organized by ODFW and NMFS.

Congratulations!